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(71) Applicant: EASTMAN KODAK COMPANY [US/US]; 343 State Street, Rochester, NY 14650 (US).

(72) Inventor: O'SHEA, Daniel, George ; 188 Brunswick Street, Rochester, NY 14607 (US).

(74) Agent: RANDALL, Robert, L.; 343 State Street, Rochester, NY 14650 (US).

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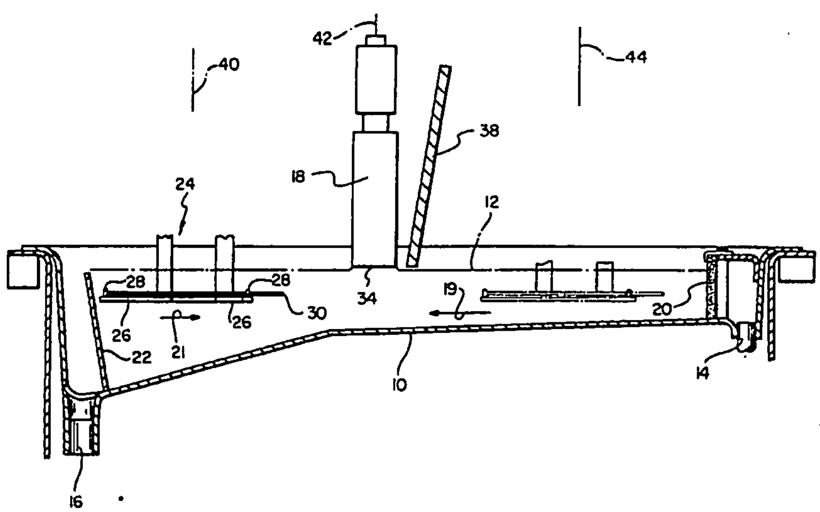

(57) Abstract

An improved method and apparatus for cleaning semi-conductor wafers (30) in a liquid bath including means (14) for supplying the bath with a liquid media such as ultrapure water and with an electroacoustic transducer (18) disposed to energize the wafer (30) in the bath. The transducer (18) is energized at a frequency in the range of from about 20 kHz to 90 kHz to form a compact, well-defined area of intense cavitation in the bath. The workpiece is moved in a first direction past the transducer through the area of intense cavitation. The ultrapure water is moved past the transducer and the workpiece in a direction opposite to the direction of movement of the workpiece past the transducer. The improvement comprises the placement of the transducer (18) just above, out of contact with the surface of the bath, thereby minimizing the generation of flow turbulence in the bath which can redeposit dirt on the already cleaned surface of the wafer (30), and yet still satisfactorily imparting energy to the wafer surface when the transduceris actuated, forming a meniscus between the end of the transducer (18) and the liquid.

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ULTRASONIC CLEANING METHOD AND APPARATUS

Technical Field

The present invention is directed to an improved method and apparatus for cleaning the surface of an article with ultrasonic energy and more particularly for cleaning the surfaces of patterned and unpatterned semiconductor wafers in preparation for subsequent operations in the manufacture of semiconductor devices.

The concept of cleaning semiconductor wafer elements with ultrasonic baths has been widely promoted with many claims to successful ~~application. However, the actual application of~~ such cleaning baths has fallen short of the promise. Many patents have issued on variations on the concept of ultrasonic cleaning of semiconductor wafers using ultrasonic baths wherein the wafer to be cleaned is immersed in a solvent and is subjected to ultrasonic vibration to remove particles having a size down into the submicron range. Many of these devices have utilized ultrasonic energy having a frequency between 20kHz and 100kHz, while others have utilized high frequency energy having a frequency in the range of between 0.2 and 5.0MHz. However, it has been found with these prior art attempts at ultrasonic cleaning of semiconductor wafers that, either the particles are not removed from the surface of the wafer, or they are removed and then redeposited onto a previously cleaned portion of the wafer, or damage occurs to the wafer because of the prolonged exposure to the ultrasonic field. In either event the result is less than complete cleaning of the wafer.

With the advancement of the semiconductor

art, more and more complex devices are being incorporated into the semiconductor chips resulting in an increasing value for each chip. Moreover, decreasing sizes for the devices has resulted in increasing requirements for cleanliness since the submicron-size elements in the devices can be adversely affected by submicron-size particles. All of these factors are compounded by the industry's use of larger wafer sizes containing more and more individual chips. Thus, the ultimate cleanliness of each wafer takes on ever greater economic significance to the semiconductor manufacturer.

Background Art

In commonly assigned copending U.S. application Serial No. 864,630, filed on May 16, 1986 in the name of White, a method and apparatus for ultrasonically cleaning semiconductor wafers is disclosed. That application provides an ultrasonic bath in which it is possible to generate sufficient power to thoroughly clean the wafer surface without the problems of overheating or damaging the wafer or the transducer horn, without mechanically damaging the wafer surface or the circuitry deposited thereon, and without the problems of recontamination of the surface by particles propelled into the bath liquid.

In that application a method and apparatus is disclosed for cleaning a workpiece, such as a semiconductor wafer, in a liquid bath including means for performing the steps of disposing the workpiece on a support at a first position in the bath whereby at least one surface of the workpiece is exposed. Means is provided for supplying the bath with a liquid medium such as ultrapure water and an electroacoustic transducer which is disposed

in the medium at a second position. Means is provided for energizing the transducer with an electrical source of energy at a frequency in the range of about 20kHz to 90kHz to generate ultrasonic energy which is emitted from the transducer to form a compact, well-defined area of intense cavitation in the bath. Means is provided for providing relative movement between the workpiece and the transducer whereby the exposed surface passes through the area of intense cavitation. Means is also provided for moving the liquid medium past the transducer and the workpiece in the same direction as the transducer moves with respect to the workpiece.

In the above-identified application, as well as in all other forms of ultrasonic cleaning apparatus and methods known wherein the transducer is disposed in the bath, it has been found that the mere presence of the transducer within the bath generates flow turbulence in the bath liquid which has the undesirable result of carrying particles removed from the wafer and redepositing them on the already cleaned surface. Thus, even though the particle-removal action of these devices may be satisfactory, the ultimate cleanliness of the wafers is compromised by the redeposit of a portion of the removed particles on the already cleaned surface as a result of the turbulent liquid flow generated by the immersion of the transducer in the bath.

SUMMARY OF THE INVENTION

Surprisingly, it has been found that ultrasonic energy can be imparted to a cleaning bath without th necessity of immersing the transducer in the bath. It has been found that, by disposing the energy-radiating surface of the transducer just

above and substantially parallel with the surface of the liquid of the bath, a meniscus is formed between the end of the horn and the liquid which transfers the ultrasonic energy into the liquid in the form of a compact well-defined area of intense cavitation while generating a minimum of flow turbulence in the liquid.

Accordingly, the present invention provides a method of cleaning a workpiece in a liquid bath with an electroacoustic transducer comprising the steps of: disposing a workpiece in the bath with at least one surface of the workpiece exposed; providing the bath with a supply of a liquid; and generating relative movement between the transducer and the workpiece whereby the workpiece passes in opposition to the transducer. The improvement comprises the steps of: disposing the transducer with the energy-radiating end thereof in close proximity above the surface of the liquid; and energizing the transducer with a source of energy to generate ultrasonic energy and forming a meniscus between the end of the transducer and the liquid, thereby transfering energy into the liquid to clean the workpiece while generating a minimum of flow turbulence in the liquid.

Further, the present invention provides apparatus for cleaning a workpiece in a liquid bath comprising means for forming a liquid bath, a workpiece support means, means for disposing a workpiece on the support means at a first position with at least one surface of the workpiece exposed, and means for immersing the workpiece in the bath. Means is provided for supplying the bath with a supply of ultrapure water. An electroacoustic transducer means is disposed at a second position

with the energy-radiating surface thereof disposed parallel with and just above the surface of the liquid in the bath. Means is provided for energizing the transducer with a source of energy providing an output from the transducer of from 70 to 120 watts per square inch of radiating surface of the transducer at a frequency in the range of about 20kHz to 90kHz for forming a meniscus between the end of the transducer and the liquid, emitting ultrasonic energy into the bath to form a compact well-defined area of intense cavitation. Means is also provided for moving the support means and the workpiece in a first direction from the first position past the transducer with the one surface of the workpiece facing the radiating surface at a distance of from about 1/8 of an inch to about 3/4 inch from the radiating surface thereof and within the area of intense cavitation. Means is provided for moving the ultrapure water past the transducer and workpiece in a direction opposite to the movement of the workpiece past the transducer, and means is provided for removing the workpiece from the bath.

Various means for practicing the invention and other features and advantages thereof will be apparent from the following detailed description of illustrative preferred embodiments of the invention, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of apparatus for carrying out the method of ultrasonic cleaning of articles in accordance with the present invention;

FIGS. 2a and 2b are schematic illustrations of the fluid flow of a bath of the prior art; and

FIGS. 3a and 3b are schematic illustrations of the fluid flow of a bath according to the present invention.

BEST MODE OF CARRYING OUT THE INVENTION

Referring now to FIG. 1 there is illustrated apparatus for cleaning semiconductor wafers comprising a generally open topped tank 10 arranged to contain a liquid bath having a liquid level 12, a liquid inlet 14 and a liquid outlet 16 at opposite ends thereof. An ultrasonic transducer 18 having a radiating surface 34 is disposed substantially midway between the inlet and the outlet. The electroacoustic transducer imparts an ultrasonic vibration through a horn which in turn ultrasonically develops a compact, well-defined intense cavitation field within the bath contained within tank 10. The bath container 10 is provided with a width somewhat greater than the diameter of the largest semiconductor wafer intended for use therein. The length of the bath is at least twice the diameter of the largest wafer. The inlet end of the bath is provided with a flow diffuser 20 arranged to generate generally non-turbulent flow throughout the bath area from fluid introduced through inlet 14. The outlet end of the tank is provided with a fluid level-controlling weir 22 which functions to establish and control the liquid level. Drain openings may be provided at the base of the weir to remove liquid media and settled particulates.

A workpiece transport means 24 is provided with a pair of movable arms 26 which are movable to grip, via pins 28, a workpiece 30 which, in the preferred embodiment, is a semiconductor wafer from which a plurality of semiconductor chips may be

produced. Preferably the workpiece is gripped at the edges thereof leaving both surfaces open to contact with the bath fluid and to minimize particulate generation on the surfaces. In the embodiment illustrated, the upper surface of the workpiece 30 is intended to be the primary surface operated upon by the action of the ultrasonic transducer 18, but in fact both surfaces will undergo cleaning as the wafer is passed through the influence of the horn. In addition to the movement of the arms 26 to grip the semiconductor wafer 30, the workpiece transport 24 is also arranged for vertical movement to receive the wafer from a wafer transporter above the bath and to lower the wafer below the surface of the bath and for lateral motion along the length of the bath from the first, entrance position 40, illustrated in full in FIG. 1, in a first direction to transport the wafer to the right beneath the radiating surface of the transducer, located at a second position 42, and then to a third, exit position 44 at the opposite end of the bath, illustrated in phantom in FIG. 1. The workpiece transport may provide a range of transport speeds to the wafer of from 1 to 3 inches per second. The workpiece transport is then arranged to lift the cleaned wafer out of the tank and to release it for transfer to other operational stations. The support is then lowered to clear the horn and returned to the first position to receive the next wafer. A wall 38 is shown on the right side of the transducer which terminates just above the surface of the liquid and is provided to illustrate that the exit end of the bath is preferably disposed in a clean-room atmosphere to minimize recontamination of the waf r while that is

not necessarily so for the entrance side of the apparatus.

As illustrated in FIG. 1, the energy-radiating surface 34 of the electroacoustic transducer is disposed substantially parallel with and just above the surface of the liquid of the bath. Surprisingly, it has been found that, contrary to prior belief, it is not necessary to submerge the energy-radiating surface of the transducer beneath the liquid level in order to transfer the ultrasonic energy into the cleaning bath and to the part therein to be cleaned. With the radiating surface of the transducer disposed a distance of from 0.075 to 0.100 inch above the surface of the liquid, when energized, the transducer forms a meniscus with the liquid, effectively coupling the transducer to the liquid. Not only is the ultrasonic energy transfered into the liquid bath and the workpiece therein to be cleaned, but turbulence imparted to the laminar flow liquid by the transducer is significantly reduced, if not eliminated. Thus, the amount of particulate matter removed from the workpiece by the ultrasonic energy which is redeposited on the cleaned surface by turbulence in the liquid flow is also significantly reduced, increasing the effectiveness and efficiency of the cleaning process. The reduction in flow turbulence is illustrated by comparing the flows illustrated by the arrows in Figs. 2 and 3 wherein the "a" portions schematically illustrate a sectional side view of the liquid flows of the prior art (Fig. 2a) and with the present invention (Fig. 3a), and the "b" portions illustrate the corresponding plan views of the liquid flow. It will be noted in the arrangement utilizing the

present invention that significantly reduced flow turbulence occurs.

The energy in the cavitation field propels particles dislodged from the wafer surface across the wafer in the direction of the fluid flow across the wafer. The electroacoustic transducer 18 is arranged to provide an output of from about 70 to about 120 watts per square inch of radiating surface of the horn at a frequency in the range of about 20kHz to 90kHz, emitting ultrasonic energy into the bath to form a compact, well-defined area of intense cavitation therein. The transport is adjustable to provide a range of distances between the radiating surface of the horn 34 and the top surface of the wafer 30 of from between about 1/8 of an inch to about 3/4 inch.

While the bath may be provided with any liquid media or combination of liquid media which has been found satisfactory for cleaning workpieces such as semiconductor wafers, it has been found that the use of ultrapure water provides certain advantages over other types of fluids. (Ultrapure water is intended to refer to filtered and deionized water having a resistivity of at least 18 megohms, as is known in the art.) Primarily, the ultrapure water provides an excellent solvent action for most contaminants on semiconductor wafers. Secondarily, ultrapure water has the added advantage of leaving less residue which itself may contaminate the semiconductor wafer surface. As noted above, the fluid is introduced through inlet 14 and passes through a diffuser 20 which provides a uniform, laminar, and therefore non-turbulent, flow of the fluid from the inlet 14 to the outlet 16 passing the wafer and the electroacoustic transducer horn in a

direction opposite to that of the movement of the wafer past the horn. The liquid is supplied to the bath in a quantity of from one to three gallons per minute to provide a flow of one to three inches per second past the ultrasonic horn. The bath is provided with a depth that is generally constant from the inlet diffuser 20 to just beyond the ultrasonic horn 18, with the depth then progressively increasing toward the outlet 16. The purpose of the increasing depth from about the location of the horn is to assure that the flow of liquid decreases as it passes the horn so that the larger contaminants displaced from the surface of the workpiece 30 may settle in the bath and not be subjected to agitation whereby they may be redeposited upon the portion of the surface of the the workpiece which has already been cleaned.

According to a preferred embodiment of the present invention, a semiconductor wafer is supplied to the workpiece transport means 24 which at that time is raised above the bath at the first (left in the illustration) position and the bath is provided with a flow of ultrapure water of approximately one inch per second from the inlet to the outlet, generally in the direction indicated by arrow 19. The electroacoustic transducer 18 is energized with a source of energy providing an output of about 100 watts per square inch of the radiating surface of the horn at a frequency of about 20kHz emitting ultrasonic energy into the bath to form a compact, well-defined area of intense cavitation in the bath. The workpiece transport then lowers the wafer into the bath and then travels with the wafer in the direction indicated by arrow 21 from the first position, generally indicated at 40, toward

and past the radiating surface of the ultrasonic transducer at a second position 42, to the third, exit position 44. Preferably the wafer is disposed at a spacing of about 3/8 inch from the face of the ultrasonic transducer so that the cavitation energy in the bath dislodges any foreign particles disposed thereon which are then carried away by the liquid towards the outlet of the bath.

In other embodiments (not illustrated) the wafer may remain stationary within the bath while the transducer is moved therepast. Such an arrangement can utilize a shorter bath since the wafer need not move, but there may be a greater risk of recontamination of the cleaned wafer surface. In such an arrangement, the flow of the liquid media would be in the same direction as the relative movement of the transducer with respect to the wafer surface.

The cavitation action of the ultrasonic horn has been found to form minute vapor bubbles which then collapse, generating localized pressures of up to 200,000 psi. These pressures release energy to dislodge the particles from the semiconductor surface. The effectiveness of this removal process is regulated by the energy level (watts per square inch of radiating surface) and the exposure time which is determined by the velocity of the wafer. It will also be appreciated that the flow of the liquid medium past the transducer and the moving workpiece, functions to move any displaced particles away from the already cleaned portion of the workpiece in a downstream direction, passing only over yet to be cleaned surfaces of the workpiece. Accordingly, the dislodged particles have less opportunity to recontaminate the already

cleaned portions of the workpiece. This action is further enhanced by the uniform, non-turbulent flow of the liquid which is not compromised by the extension of the transducer horn into the liquid bath which could destroy the non-turbulent flow. Thus any tendency of particles displaced into the liquid to be transported upstream and be redeposited on the already cleaned portion of the workpiece is minimized. Moreover, it is noted that the flow of the liquid past the transducer and the workpiece prevent build-up of heat which might otherwise occur when operating at the high power values of the present invention.

INDUSTRIAL APPLICABILITY

With the use of the method and apparatus of the present invention it is possible to clean up to 160 wafers per hour. The cleanliness level possible with the present invention is less than 0.05 particles per square centimeter of a size equal to or larger than 0.2 microns. Still further, it is unnecessary to degas the liquid prior to cleaning of the workpieces and the continuous flow of the bath prevents the build-up of contaminants within the bath.

I Claim:

1. In the method of cleaning a workpiece in a liquid bath having a substantially open upper liquid surface with an electroacoustic transducer comprising the steps of:

disposing a workpiece in said bath with at least one surface of the workpiece exposed;

providing said bath with a supply of a liquid;

generating relative movement between said transducer and said workpiece whereby said workpiece passes in opposition to said transducer; the improvement comprising the steps of:

disposing said transducer with the energy-radiating end thereof in sufficiently close proximity above the upper surface of the liquid that energization of said transducer will create a meniscus with said liquid; and

energizing said transducer with a source of energy to generate ultrasonic energy and forming a meniscus between the end of the transducer and the liquid thereby transfering energy into the liquid to clean said workpiece while generating a minimum of flow turbulence in said liquid.

2. The invention according to Claim 1 wherein said transducer is stationary and the workpiece is moved past the transducer.

3. The invention according to Claim 1 wherein said workpiece is stationary and the transducer is moved past the workpiece.

4. The invention according to Claim 1 including the step of providing said bath with ultrapure water.

5. The invention according to Claim 1 wherein the source of energy provides from 70 to 120

watts per square inch of radiating surface of said transducer.

6. The invention according to Claim 1 including the step of passing said one surface of said workpiece past the radiating surface of said transducer at a distance of from about 1/8 of an inch to about 3/4 inch.

7. The invention according to Claim 1 wherein the surface of the energy-radiating end of the transducer is disposed substantially parallel with the surface of the liquid.

8. In the method of cleaning a workpiece in a liquid bath having a substantially open upper liquid surface with an electroacoustic transducer comprising the steps of:

disposing a workpiece on a support at a first position in said bath with at least one surface of the workpiece exposed;

providing said bath with a supply of a liquid medium;

generating relative movement between said transducer and said workpiece whereby said workpiece passes in opposition to said transducer; and

moving said liquid medium past said workpiece in the same direction as the transducer moves with respect to the workpiece whereby particles dislodged from the surface of said workpiece are moved across the workpiece in the direction of the movement of the liquid medium thereacross, the improvement comprising the steps of:

disposing the energy-radiating end of said transducer in sufficiently close proximity above the upper surface of the liquid medium that energization of said transducer will create a meniscus with said

liquid; and

energizing said transducer with a source of energy at a frequency in the range of about 20kHz to 90kHz to generate ultrasonic energy which is emitted into said bath and forms a meniscus between said end of the transducer and the liquid thereby transfering energy into the liquid medium in the form of a compact well-defined area of intense cavitation while generating a minimum of flow turbulence in said liquid medium.

9. The invention according to Claim 8 wherein the surface of the energy-radiating end of the transducer is disposed substantially parallel with the surface of the liquid.

10. The method of cleaning semiconductor wafers in a liquid bath having a substantially open upper liquid surface comprising the steps of:

disposing a semiconductor wafer on a support at a first position whereby at least one surface of the wafer is exposed;

immersing the wafer in said bath;

providing said bath with a supply of ultrapure water;

disposing an electroacoustic transducer at a second position with the radiating surface thereof disposed substantially parallel with and just above the surface of said liquid;

energizing said transducer with a source of energy providing from 70 to 120 watts per square inch of radiating surface of said transducer at a frequency in the range of about 20kHz to 90kHz to generate ultrasonic energy which is emitted into said bath and forms a meniscus between said end of the transducer and the liquid thereby transfering energy into the liquid medium in the form of a

compact well-defined area of intense cavitation;

moving said wafer in a first direction from said first position past said transducer with said one surface of said workpiece facing said radiating surface at a distance from about 1/8 of an inch to about 3/4 inch from the radiating surface thereof and within said area of intense cavitation;

moving said ultrapure water with non-turbulent flow past said transducer and said wafer in a direction opposite to the movement of said wafer past said transducer; and

removing said wafer from said bath.

11. In an apparatus for cleaning a workpiece in a liquid bath comprising:

a workpiece support means;

means forming a liquid bath having a substantially open upper liquid surface;

means for disposing a workpiece on said support means at a first position in said bath with at least one surface of the workpiece exposed;

means for supplying said bath with a liquid medium;

electroacoustic transducer means disposed at a second position;

means for energizing said transducer with a source of energy at a frequency in the range of about 20kHz to 90kHz for emitting ultrasonic energy into said bath in the form of a compact well-defined area of intense cavitation in said bath;

means for relatively moving said support means and said workpiece with respect to said transducer whereby said one surface passes through said area of intense cavitation; and

means for moving said liquid medium past said workpiece in the same direction as the

transducer moves with respect to the workpiece; the improvement comprising:

means for disposing said transducer means with the energy-radiating surface thereof just above the surface of said liquid in said bath whereby a meniscus is formed between the transducer and the liquid when the transducer is energized.

12. The invention according to Claim 11 wherein the radiating surface of the transducer is disposed substantially parallel with the surface of the liquid in said bath.

13. The invention according to Claim 11 wherein said workpiece is stationary and the transducer is moved past said workpiece.

14. The invention according to Claim 11 wherein said transducer is stationary and the workpiece is moved past said transducer.

15. The invention according to Claim 11 wherein said bath is provided with ultrapure water.

16. The invention according to Claim 11 wherein said source of energy provides an output from said transducer of from 70 to 120 watts per square inch of radiating surface of said transducer.

17. The invention according to Claim 11 including means for passing said one surface of said workpiece past the radiating surface of said transducer at a distance of from about 1/8 of an inch to about 3/4 inch and within said area of intense cavitation.

18. Apparatus for cleaning a workpiece in a liquid bath comprising:

means for forming a liquid bath having a substantially open upper liquid surface;

a workpiece support means;

means for disposing a workpiece on said support means at a first position with at least one surface of the workpiece exposed;

means for immersing the workpiece in said bath;

means for providing said bath with a supply of ultrapure water;

electroacoustic transducer means disposed at a second position with the energy-radiating surface thereof disposed parallel with and just above the surface of the liquid in the bath;

means for energizing said transducer with a source of energy providing an output from said transducer of from 70 to 120 watts per square inch of radiating surface of said transducer at a frequency in the range of about 20kHz to 90kHz for forming a meniscus between the end of the transducer and the liquid thereby emitting ultrasonic energy into said bath to form a compact well-defined area of intense cavitation in said bath;

means for moving said support means and said workpiece in a first direction from said first position past said transducer with said one surface of said workpiece facing said radiating surface at a distance of from about 1/8 of an inch to about 3/4 inch from the radiating surface thereof and within said area of intense cavitation;

means for moving said ultrapure water past said transducer and workpiece in a direction opposite to the movement of said workpiece past said transducer; and

means for removing said workpiece from said bath.

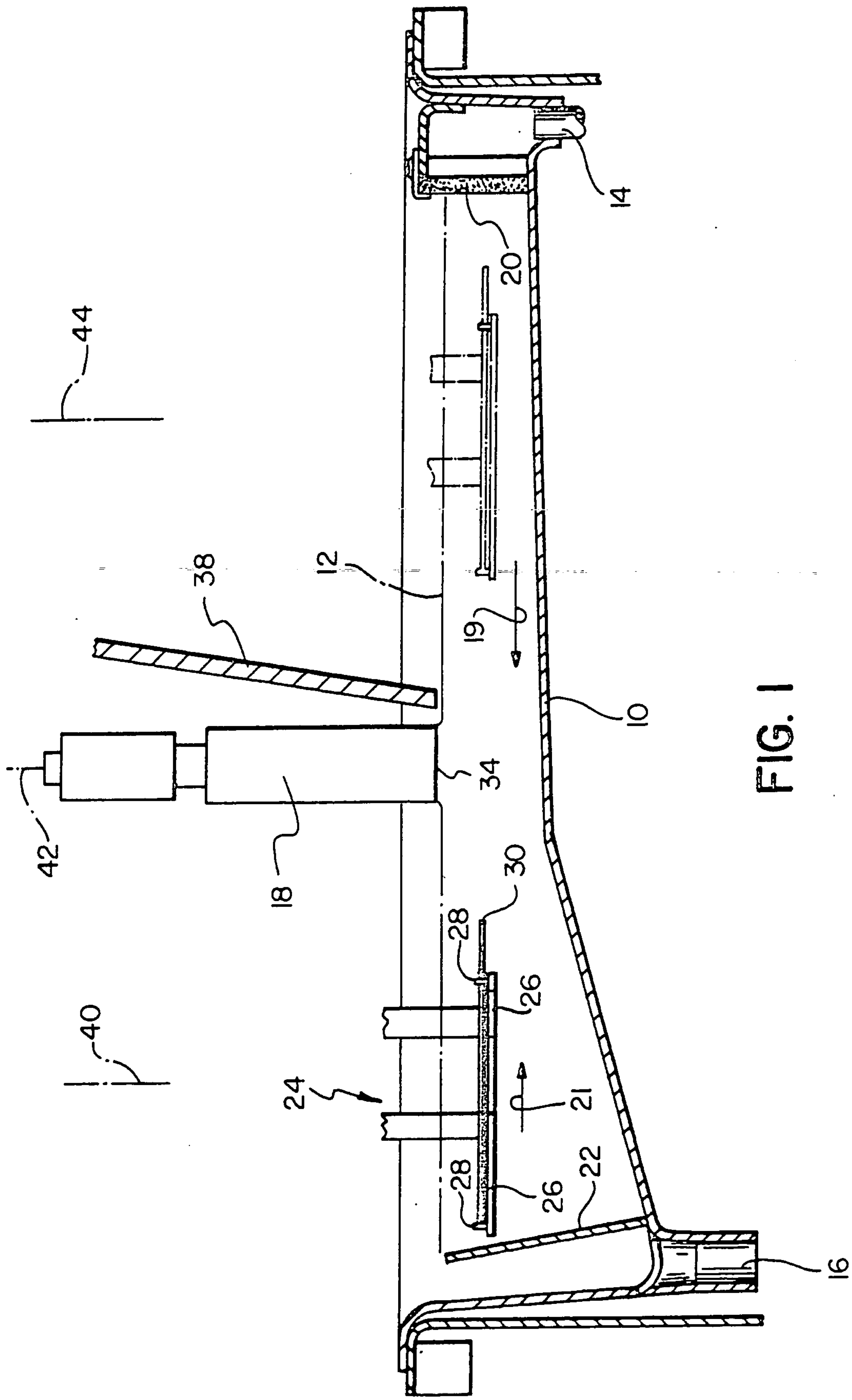

FIG. I

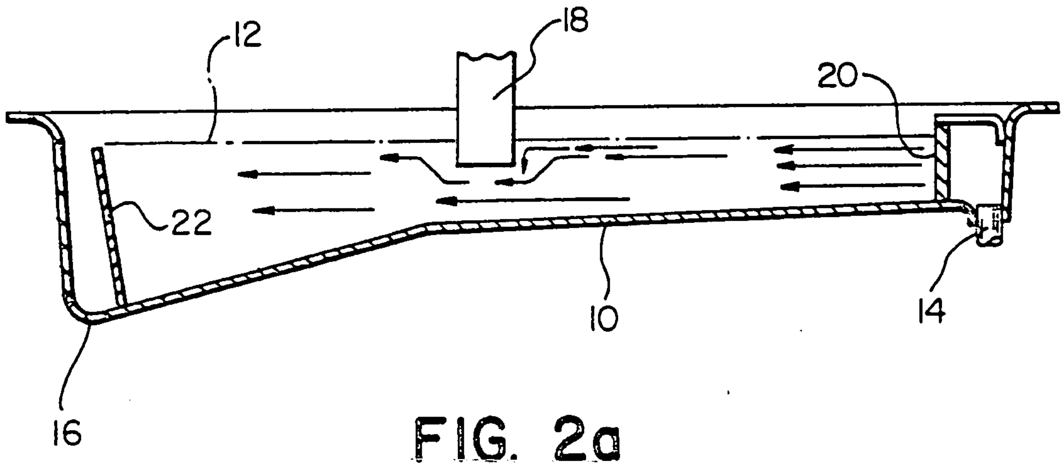

FIG. 2a

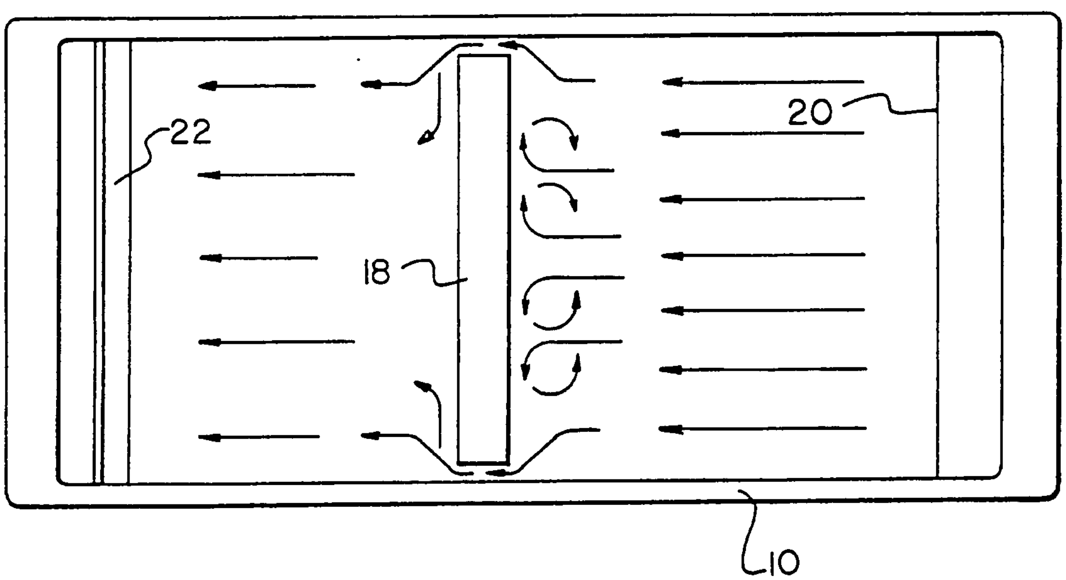

FIG. 2b

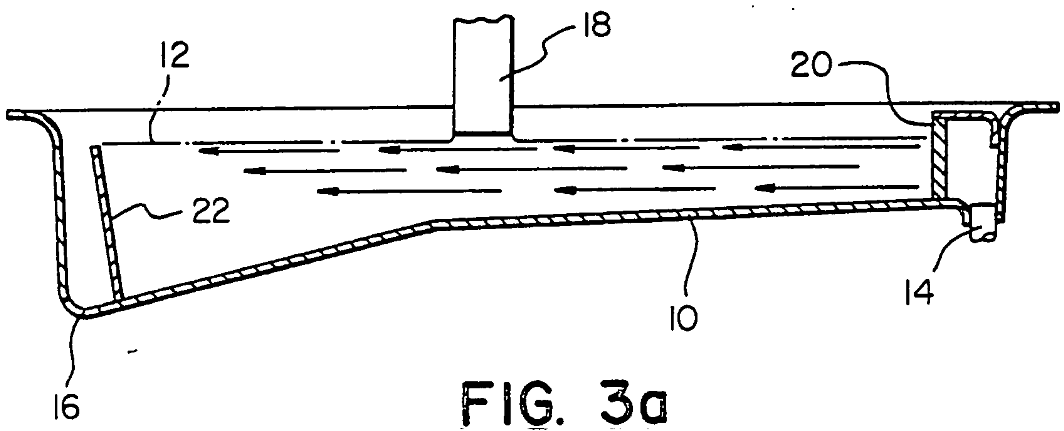

FIG. 3a

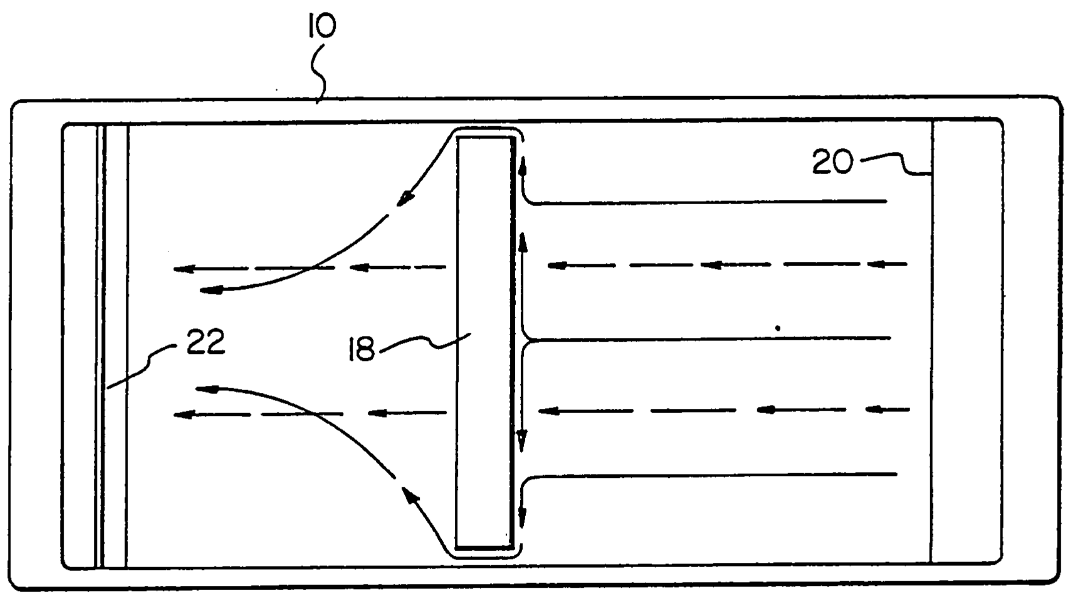

FIG. 3b

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 87/03214

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: B 08 B 3/12; H 01 L 21/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	B 08 B; H 01 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
P,A	WO, A, 87/06862 (EASTMAN KODAK CO.) 19 November 1987 see the whole document cited in the application	1
A	US, A, 4178188 (DUSSAULT) 11 December 1979 see column 4, lines 3-39; figures 1,2	1
A	DE, A, 3338477 (MENSING) 2 May 1985	

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* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10th march 1988	14 APR 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

US 8703214
SA 20040

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 30/03/88
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A- 8706862	19-11-87	None	
US-A- 4178188	11-12-79	None	
DE-A- 3338477	02-05-85	None	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82